

II. BACKGROUND

A. Objective and Approach

1. Objective and Key Issues

The objective of this study was to assess the effectiveness of the use of modeling and simulation (M&S) in the weapons system acquisition and support processes. These support processes include the systems engineering process, and evolving processes such as concurrent engineering (CE) and Integrated Product and Process Development (IPPD). The assessment addresses the following key questions:

- What are the metrics that can be and are being used to evaluate M&S effectiveness in the acquisition process?
- What specific M&S tools are emerging that are being used by Government and Industry to facilitate the design, development, manufacturing, test, and support of weapons systems in an IPPD environment?
- What are the associated benefits of using M&S in the acquisition environment?
- What are the key M&S challenges that remain that preclude the use of M&S in a seamless way within the acquisition process?

2. Approach

Recent and focused information on policy guidance and direction was obtained through a series of visits. Important M&S facilities and efforts were prioritized for potential visits in order to gather the best possible information on the use of M&S by field agencies. A list of the key offices and agencies visited follows in section A.3 of this chapter.

Issues important to the study were framed in the form of a focus paper which presented the desired questions in a flexible format. The goal was to avoid use of a survey or 'fill in the blanks' document in order to identify and come to terms with key substantive issues. The focus paper was normally tailored for each organization visited and was updated over the course of the study to include or highlight key issues. Previous assessment efforts and documents facilitated development of the focus paper. For example, the Acquisition Task Force on M&S (ATFMS) had placed significant emphasis on developing appropriate questions to be used during visits to a series of similar organizations. Such questions were used in order to capture issues key to the study's objectives.

The study team also conducted an extensive literature search on M&S initiatives and activities. This was conducted using local libraries, including the Pentagon's Army library, Defense Systems Management College (DSMC) library, SAIC's Corporate Technical Resource Acquisition Center, public libraries, the World Wide Web (WWW), the Computer Select system, and similar sources.

Interface with organizations and agencies involved in the systems acquisition process was the key step in becoming familiar with the breadth and depth of M&S use and related benefits, problems, and successes. By understanding the underlying policies and procedures, barriers, and metrics, the study team could gather the information necessary to focus on actual costs and benefits of M&S in DoD acquisition. While the intuitive and probably correct answer is that M&S benefits the acquisition process, this study sought the details to provide a more quantitative answer.

During several visits the study team interfaced with subordinate (labs, agencies, divisions, or offices) and tenant or affiliated (consortia, contractors, other) groups collocated with or near the main organization. On most visits, the study team was provided with significant amounts of material tailored to the questions in the focus paper, especially pertaining to metrics, new and evolving M&S tools, challenges, and costs/benefits. The team developed a summary of the visit from notes and data to ensure historical capture of key insights and observations. Copies of the summaries are on file.

3. Organizations Visited

Time and available resources limited the total number of visits, but many key organizations and individuals were visited during the course of this study. Their experience and insights were essential to gaining an appreciation of the benefits and the challenges associated with M&S, as well as developing a method to best quantify the benefits of M&S in the acquisition process. The organizations and primary POCs are summarized in Table II-1.

While specific reports of these visits are not included in this report, the data collected during the visits is incorporated and referenced throughout Chapters III and IV. We are grateful for the courtesies extended and the information shared in the many visits and discussions.

TABLE II-1: EXAMPLES OF KEY VISITS

SERVICE-LEVEL POLICY AND MANAGEMENT:

Deputy Under Secretary of the Army (Operations Research)	Mr. Walt Hollis
Special Assistant for M&S to Asst Sec of the Navy (RDA)	Mr. Ben Helme
Air Staff (AF T&E)	Maj. Bryan Ishihara
Office of Assistant Secretary of the Army (RDA)	Dr. Herb Fallin
Defense Advanced Research Projects Agency (DARPA)	Dr. Gary Jones
Army Staff, T&E Management Activity (TEMA)	Dr. John Foulkes
Office of Assistant Secretary of the Navy (RDA)	Mr. Mike Roberts
HQ, Naval Sea Systems Command	Mr. Dan Billingsley

R&D AND T&E ACTIVITIES:

Navy M&S War Room Project Management Ofc.
USAF Arnold Engineering Development Center (AEDC)
USA T&E Command (TECOM) and Aberdeen Test Center
Patuxent River Naval Air Combat Environment T&E Center
US Army Redstone Technical Test Center (RTTC)
USA Tank Automotive RD&E Center (TARDEC)
DoN/DoC Center of Exc. For Best Manufacturing Practices
Naval Air Warfare Center Weapons Div (NAWCWPNS)
Air Force Flight Test Center (AFFTC), Edwards AFB

PROGRAM OFFICES AND PEOs:

F-22
SC-21
AFATDS (Advanced Field Artillery Tactical Data System)
Army Tactical Missiles PEO (Program Executive Office)
COMANCHE
JSF (Joint Strike Fighter)
TOMAHAWK
NSSN (New Attack Submarine program)
Javelin
Longbow Hellfire
MLRS (Multiple Launch Rocket System)

SAMPLE INDUSTRY VISITS:

National Automotive Center (NAC)
Automotive Research Center (ARC)
Deneb Robotics, Inc
Ford Motor Company
Lockheed Martin, Palo Alto, CA
Sikorsky Helicopter
General Dynamics, Electric Boat Div
General Motors, Truck & Bus Div

B. Related Studies

Improvements in M&S tools to support acquisition are closely interwoven with initiatives to improve the overall acquisition process. The Packard Commission highlighted significant process flaws in their 1986 Report to the Congress. In 1993, then-Secretary of Defense Aspin and others, including Dr. John M. Deutch, proposed acquisition reforms bolder than those proposed by the Packard Commission. Also in 1993, now Secretary of Defense Dr. Perry, in Acquisition Reform: A Mandate for Change, described the problem areas in the acquisition process as follows:

DoD's acquisition process is not sufficiently streamlined, flexible, agile, efficient, timely or effective. The acquisition community has not been sufficiently innovative, has not used technology to re-engineer itself, and has tended to use functional stovepipes rather than integrated decision teams.

Numerous recent studies have been conducted which deal with the benefits and limitations in DoD use of M&S in support of the acquisition process. Most of these studies were reviewed for their applicability to this effort and some ideas on how to measure the contribution of M&S were identified, but none directly addressed the effectiveness of M&S tools and processes in support of the acquisition process. More comprehensive summaries can be found in Appendix C.

C. Acquisition Guidance

1. OSD Guidance

Before examining how program managers are employing M&S, it is appropriate to review the guidance given by OSD to the Services, and in turn the direction the Services give to the acquisition managers.

The acquisition environment has many new challenges including downsizing, reduced funding, and the need to reduce the time and resources needed for integrating advanced technologies into new systems. The goal is to procure state-of-the-art technology and products 'better, faster, and cheaper' while also helping to transition DoD and its contractors to the new methods and tools that enable advanced acquisition.

Secretary of Defense Perry recently spoke at an Operational Test Agency (OTA) Commander's Conference and discussed five key themes: better use of M&S; focus testing where M&S can't be applied; combine tests (developmental and operational, or operational testing for two or more systems) when possible; combine testing with training or operations; and early involvement of testers.

In his keynote address to the Defense Modeling and Simulation Office Fifth Annual Industry Briefing on Modeling and Simulation in May 1996, the Under Secretary of Defense (USD), Acquisition and Technology (A&T), Dr. Paul G. Kaminski, discussed the critical and increasing role of modeling and simulation in acquisition. He stated that:

The bottom line is that integrated product and process development, backed up by a strong commitment to computer based modeling and simulation tools, provides a dominant competitive edge in the commercial marketplace and a clear warfighting edge on the battlefield. It provides a path for getting to market first and at a lower cost.

A recent interview with Philip Coyle, Director of Operational Test and Evaluation in OSD, in Program Manager magazine highlights some key areas of M&S emphasis. The key is to make testing more efficient. This can happen by involving testers early in the acquisition process, starting before the request for proposal (RFP) and during development of the operational requirements document (ORD). It also requires involving the OTAs and the Joint Interoperability Test Center (JITC) up front. He also identified the need for better use of M&S including tools that are more predictive (high probability of giving the right answer as a result of being based on real science, or 'physics-based').

DoD Directive 5000.1 encourages the use of M&S and states:

Models and simulations shall be used to reduce the time, resources, and risks of the acquisition process and to increase the quality of the systems being acquired. Representations of proposed systems (virtual prototypes) shall be embedded in realistic, synthetic environments to support the various phases of the acquisition process, from requirements determination and initial concept exploration to the manufacturing and testing of new systems, and related training.

In addition, DoD 5000.2-R states:

Accredited modeling and simulation shall be applied, as appropriate, throughout the system life-cycle in support of the various acquisition activities: requirements definition; program management; design and engineering; efficient test planning; result prediction; and to supplement actual test and evaluation; manufacturing; and logistics support. PMs shall integrate the use of modeling and simulation within program planning activities, plan for life-cycle application, support, and reuse models and simulations, and integrate modeling and simulation across the functional disciplines.

The DoD M&S Master Plan (DoD 5000.59-P) states the vision as follows:

Defense modeling and simulation will provide readily available, operationally valid environments for use by the DoD Components:

- To train jointly, develop doctrine and tactics, formulate operational plans, and assess warfighting situations.

- To support technology assessment, system upgrade, prototype and full-scale development, and force structuring.

- Furthermore, common use of these environments will promote a closer interaction between the operations and acquisition communities in carrying out their respective responsibilities. To allow maximum utility and flexibility, these modeling and simulation environments will be constructed from affordable, reusable components interoperating through an open systems architecture.

2. Service Guidance

Guidance for the use of M&S in weapon systems acquisition in the Services varies. The Navy employs different organizations to address oversight, policy, technical support, and use of M&S, because of the breadth of functional disciplines which Navy M&S supports. US Marine Corps M&S efforts are integrated into portions of the Navy's M&S structure and there is also a steering group and management office for USMC-specific functions and systems.

The Navy is establishing a PEO for Synthetic Operations, but the functions and responsibilities of this office have yet to be approved. The Navy also has a War Room for M&S for better integration of M&S functions and systems. Designed to work on M&S planning and implementation across the Navy, from initial requirements to system logistical support, the War Room also works on short term projects such as the Navy M&S Master Plan and the Navy's VV&A Instruction.

The Army Model and Simulation Office (AMSO) was charged with producing an investment plan that will focus on efficient M&S efforts. RDA is one of three domains established to support this office. This initiative was begun in 1995 and management is being implemented.

Office of the Assistant Secretary of the Army (OASA) for RDA policy memorandum, "Simulation Support to Army Acquisition," mandates use of a simulation support plan (SSP) for each Army ACAT I and II program prior to each milestone review. The long-term goal is to eliminate use of a separate SSP and integrate the M&S related information into the Acquisition Strategy Report. This will be another step in better integration of M&S into the overall acquisition process.

The Air Force has a long history of M&S applications and a growing need to improve on the use of M&S for decision-making. Significant organizational changes occurred in late 1984. The Directorate of Modeling, Simulation and Analysis (MS&A) (HQ, USAF/XOM) was designated the single point of contact for M&S. Within this organization several divisions provide support in the areas of evaluation, technical matters, warfighting, studies and analysis, operational requirements, and integrated product planning.

Most recently, the Air Force published a Functional Area Plan for Modeling and Simulation. Together with the New Vector initiative to guide Air Force M&S and the Air Force M&S Master Plan, published earlier this year, the Functional Area Plan provides the framework to integrate M&S into a single coordinated program.

D. The Traditional Acquisition Process

This section briefly summarizes the phases and milestones of the traditional acquisition process in order to create a baseline for comparison with the evolving process. The traditional process consists of distinct phases, starting with requirements generation or determination of mission need, and ending with the operations and support and eventually the retirement of the system. The phases are separated by milestone decision points where key decisions are made. These Milestone Reviews were often characterized as walls between phases which fostered a stovepiped approach that was evident throughout the process.

Most of the risk assessment was conducted early in the program, requiring use of imperfect assumptions and information (especially with regard to cost and technology). A result was imperfect expectations, and little flexibility in the system after the early stages of the program.

Members of the acquisition community who worked within this traditional process operated within their own sphere of influence with very little coordination before handing off the product to the next phase. This often fostered a situation in which different groups or teams had adversarial relationships. The Government, especially the user community, had very high expectations for the technology and the ability of the contractor to achieve success, sometimes unrealistically so. The test community played an oversight role ensuring that the evolving system met the user requirements to a suitable degree. On the other hand, the contractor and program manager sought to move the program along to the fielding or initial operational capability (IOC) stage. There was infrequent interaction between the various participants. User discovery of performance or capability shortfalls after fielding often led to expensive Engineering Change Proposals (ECPs) and modifications.

The traditional system resulted in a good examination of the final product, but failed to maximize efficiency, especially in light of the timing of requirements specification. While some M&S tools have long been employed in the acquisition process, they too were used in a stovepipe fashion with little or no use of common data across functional areas or across programs. Tools that are currently available to examine the system in a virtual manner were not available, thus a physical prototype was necessary to examine fit and function issues in detail before readiness for production.

Before the advent of integrated teams in the weapon systems development process, there was little effort made to combine testing to satisfy the different requirements, or to collect extra data in early efforts so they could be used as part of the database later in the acquisition cycle. Dwindling resources and integrated teams have made program managers more aware of the value of integrating workers from different phases and using simulations and models to accomplish multiple missions.

In spite of being bound by processes and Milestone Reviews, the community is evolving the program offices and their support into an information team that shares data and results across the phases of the acquisition process. The positive results of simulation efforts in systems engineering have become evident in what we refer to as Simulation Based Acquisition. The developments and trends in each phase of the acquisition process that are affected by the immersion in M&S use are discussed in the next chapter.